Appendix A: Emission Calculations
Criteria Pollutant Emissions from the Coal Fired Boiler U1

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Max. Heat Input Capacity MMBtu/hr: 7.410

Ash Content (A): 13.5 % (provided by the source)

Pollutant

	PM[a]	PM10[b]	PM2.5[b]	SO_2[c]	NO_X[d]	VOC[e]	CO[d]
Emission Factor	0.06 (lbs/MMBtu)	0.729 *(0.054A)* (lbs/ton)	0.324 *(0.024A)* (lbs/ton)	0.10 (lbs/MMBtu)	0.24 (lbs/MMBtu)	0.05 (lbs/ton)	0.15 (lbs/MMBtu)
Potential to Emit in (tons/yr)	**1,947**	**1,097**	**488**	**3,246**	**7,789**	**75.3**	**4,868**

[a] PM emission factor is the emission limit in 40 CFR 49.5513(d)(2).
[b] PM10 and PM2.5 emission factors are from AP-42, Table 1.1-6 (09/98) for ESP control.
[c] The SO_2 emission factor is based on the emission limit in 40 CFR 52.145(d).
[d] The NO_X and CO emission factors are based on the emission limits in the PSD Permit AZ 08-01A, issued on 2/8/12.
[e] VOC emission factor is from AP-42, Tables 1.1-19 (09/98).
The heating value of the coal used at this plant is 21.562 MMBtu/ton, provided by the source.

Methodology

PTE of PM10, PM2.5, and VOC (tons/yr) = Max. Heat Input (MMBtu/hr) / 21.562 MMBtu/ton x Emission Factor (lbs/ton) x 8760 hrs/yr x 1 ton/2,000 lbs
PTE of PM, SO_2, NOx and CO (tons/yr) = Max. Heat Input (MMBtu/hr) x Emission Factor (lbs/MMBtu) x 8760 hr/yr x 1 ton/2,000 lbs

Appendix A: Emission Calculations
Criteria Pollutant Emissions from the Coal Fired Boiler U2

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Max. Heat Input Capacity MMBtu/hr: 7.410

Ash Content (A): 13.5 % (provided by the source)

Pollutant

	PM[a]	PM10[b]	PM2.5[b]	SO_2[c]	NO_X[d]	VOC[e]	CO[d]
Emission Factor	0.06 (lbs/MMBtu)	0.729 *(0.054A)* (lbs/ton)	0.324 *(0.024A)* (lbs/ton)	0.10 (lbs/MMBtu)	0.24 (lbs/MMBtu)	0.05 (lbs/ton)	0.15 (lbs/MMBtu)
Potential to Emit in (tons/yr)	**1,947**	**1,097**	**488**	**3,246**	**7,789**	**75.3**	**4,868**

[a] PM emission factor is the emission limit in 40 CFR 49.5513(d)(2).
[b] PM10 and PM2.5 emission factors are from AP-42, Table 1.1-6 (09/98) for ESP control.
[c] The SO_2 emission factor is based on the emission limit in 40 CFR 52.145(d).
[d] The NO_X and CO emission factors are based on the emission limits in the PSD Permit AZ 08-01A, issued on 2/8/12.
[e] VOC emission factor is from AP-42, Tables 1.1-19 (09/98).
The heating value of the coal used at this plant is 21.562 MMBtu/ton, provided by the source.

Methodology

PTE of PM10, PM2.5, and VOC (tons/yr) = Max. Heat Input (MMBtu/hr) / 21.562 MMBtu/ton x Emission Factor (lbs/ton) x 8760 hrs/yr x 1 ton/2,000 lbs
PTE of PM, SO_2, NOx and CO (tons/yr) = Max. Heat Input (MMBtu/hr) x Emission Factor (lbs/MMBtu) x 8760 hr/yr x 1 ton/2,000 lbs

Appendix A: Emission Calculations
Criteria Pollutant Emissions from the Coal Fired Boiler U3

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Max. Heat Input Capacity MMBtu/hr: 7.410

Ash Content (A): 13.5 % (provided by the source)

Pollutant

	PM[a]	PM10[b]	PM2.5[b]	SO_2[c]	NO_X[d]	VOC[e]	CO[d]
Emission Factor	0.06 (lbs/MMBtu)	0.729 *(0.054A)* (lbs/ton)	0.324 *(0.024A)* (lbs/ton)	0.10 (lbs/MMBtu)	0.24 (lbs/MMBtu)	0.05 (lbs/ton)	0.15 (lbs/MMBtu)
Potential to Emit in (tons/yr)	**1,947**	**1,097**	**488**	**3,246**	**7,789**	**75.3**	**4,868**

[a] PM emission factor is the emission limit in 40 CFR 49.5513(d)(2).
[b] PM10 and PM2.5 emission factors are from AP-42, Table 1.1-6 (09/98) for ESP control.
[c] The SO_2 emission factor is based on the emission limit in 40 CFR 52.145(d).
[d] The NO_X and CO emission factors are based on the emission limits in the PSD Permit AZ 08-01A, issued on 2/8/12.
[e] VOC emission factor is from AP-42, Tables 1.1-19 (09/98).
The heating value of the coal used at this plant is 21.562 MMBtu/ton, provided by the source.

Methodology

PTE of PM10, PM2.5, and VOC (tons/yr) = Max. Heat Input (MMBtu/hr) / 21.562 MMBtu/ton x Emission Factor (lbs/ton) x 8760 hrs/yr x 1 ton/2,000 lbs
PTE of PM, SO_2, NOx and CO (tons/yr) = Max. Heat Input (MMBtu/hr) x Emission Factor (lbs/MMBtu) x 8760 hr/yr x 1 ton/2,000 lbs

Appendix A: Emission Calculations
HAP Emissions
From the Coal Fired Boilers U1 through U3

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Emission Unit:	**Boiler U1**	**Boiler U2**	**Boiler U3**
Max. Heat Input Capacity (MMBtu/hr):	**7,410**	**7,410**	**7,410**

Pollutant	Emission Factor	Unit	PTE of HAP for B1 (tons/yr)	PTE of HAP for B2 (tons/yr)	PTE of HAP for B3 (tons/yr)
Total PCDD	6.66E-10	(lbs/ton)	1.00E-06	1.00E-06	1.00E-06
Total PCDF	1.09E-09	(lbs/ton)	1.64E-06	1.64E-06	1.64E-06
Total PAH	2.08E-05	(lbs/ton)	0.03	0.03	0.03
Acetaldehyde	5.70E-04	(lbs/ton)	0.86	0.86	0.86
Acetophenone	1.50E-05	(lbs/ton)	0.02	0.02	0.02
Acrolein	2.90E-04	(lbs/ton)	0.44	0.44	0.44
Benzene	1.30E-03	(lbs/ton)	1.96	1.96	1.96
Benzyl Chloride	7.00E-04	(lbs/ton)	1.05	1.05	1.05
DEHP	7.30E-05	(lbs/ton)	0.11	0.11	0.11
Bromoform	3.90E-05	(lbs/ton)	0.06	0.06	0.06
Carbon Disulfide	1.30E-04	(lbs/ton)	0.20	0.20	0.20
2-Chloroacetophenone	7.00E-06	(lbs/ton)	0.01	0.01	0.01
Chlorobenzene	2.20E-05	(lbs/ton)	0.03	0.03	0.03
Chloroform	5.90E-05	(lbs/ton)	0.09	0.09	0.09
Cumene	5.30E-06	(lbs/ton)	0.01	0.01	0.01
Cyanide	2.50E-03	(lbs/ton)	3.76	3.76	3.76
2,4-Dinitrotoluene	2.80E-07	(lbs/ton)	0.00	0.00	0.00
Dimethyl Sulfate	4.80E-05	(lbs/ton)	0.07	0.07	0.07
Ethyl Benzene	9.40E-05	(lbs/ton)	0.14	0.14	0.14
Ethyl Chloride	4.20E-05	(lbs/ton)	0.06	0.06	0.06
Ethylene Dichloride	4.00E-05	(lbs/ton)	0.06	0.06	0.06
Ethylene Dibromide	1.20E-06	(lbs/ton)	0.00	0.00	0.00
Formaldehyde	2.40E-04	(lbs/ton)	0.36	0.36	0.36
Hexane	6.70E-05	(lbs/ton)	0.10	0.10	0.10
Isophorone	5.80E-04	(lbs/ton)	0.87	0.87	0.87
Methyl Bromide	1.60E-04	(lbs/ton)	0.24	0.24	0.24
Methyl Chloride	5.30E-04	(lbs/ton)	0.80	0.80	0.80
Methyl Hydrazine	1.70E-04	(lbs/ton)	0.26	0.26	0.26
Methyl Methacrylate	2.00E-05	(lbs/ton)	0.03	0.03	0.03
Methyl Tert Butyl Ether	3.50E-05	(lbs/ton)	0.05	0.05	0.05
Methylene Chloride	2.90E-04	(lbs/ton)	0.44	0.44	0.44
Phenol	1.60E-05	(lbs/ton)	0.02	0.02	0.02
Propionaldehyde	3.80E-04	(lbs/ton)	0.57	0.57	0.57
Tetrachloroethylene	4.30E-05	(lbs/ton)	0.06	0.06	0.06
Toluene	2.40E-04	(lbs/ton)	0.36	0.36	0.36
1,1,1-Trichloroethane	2.00E-05	(lbs/ton)	0.03	0.03	0.03
Styrene	2.50E-05	(lbs/ton)	0.04	0.04	0.04
Xylenes	3.70E-05	(lbs/ton)	0.06	0.06	0.06
Vinyl Acetate	7.60E-06	(lbs/ton)	0.01	0.01	0.01
Antimony	1.80E-05	(lbs/ton)	0.03	0.03	0.03
Arsenic	4.10E-04	(lbs/ton)	0.62	0.62	0.62
Beryllium	2.10E-05	(lbs/ton)	0.03	0.03	0.03
Cadmium	5.10E-05	(lbs/ton)	0.08	0.08	0.08
Chromium	2.60E-04	(lbs/ton)	0.39	0.39	0.39
Chromium (VI)	7.90E-05	(lbs/ton)	0.12	0.12	0.12
Cobalt	1.00E-04	(lbs/ton)	0.15	0.15	0.15
Lead	4.20E-04	(lbs/ton)	0.63	0.63	0.63
Manganese	4.90E-04	(lbs/ton)	0.74	0.74	0.74
Mercury*	1.20E-06	(lbs/MMBtu)	0.04	0.04	0.04
Nickel	2.80E-04	(lbs/ton)	0.42	0.42	0.42
Selenium	1.30E-03	(lbs/ton)	1.96	1.96	1.96
Hydrogen Fluoride*	5.30E-05	(lbs/MMBtu)	1.72	1.72	1.72
Hydrogen Chloride*	7.70E-05	(lbs/MMBtu)	2.50	2.50	2.50
Total			**22.7**	**22.7**	**22.7**

Note: Emission factors are from AP-42, Tables 1.1-12, 1.1-13, 1.1-14, and 1.1-18 for Coal Combustion (09/98).
* Hg emission factor is based on the Hg emission limit in 40 CFR 63, Subpart UUUUU.
** HF and HCl emission factors are based on the stack testing results in April, 2010, provided by the source.
The heating value of the coal used at this plant is 21.562 MMBtu/ton, provided by the source.

Methodology

PTE of HAP (tons/yr) = Max. Heat Input (MMBtu/hr) / 21.6 MMBtu/ton x Emission Fator (lbs/ton) x 8760 hrs/yr x 1 ton/2000 lbs
PTE of Hg, HF, and HCl (tons/yr) = Max. Heat Input (MMBtu/hr) x Emission Factor (lbs/MMBtu) x 8760 hr/yr x 1 ton/2,000 lbs

Appendix A: Emission Calculations
No. 2 Fuel Oil Combustion
(MMBtu/hr > 100)
From Two (2) 308 MMBtu/hr Auxiliary Boilers

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Heat Input Capacity MMBtu/hr		Max. Fuel Usage (kgal/hr)		S = Weight % Sulfur
308	(each)	2.24	(each)	0.05

	Pollutant					
	PM	PM10	PM2.5	SO_2	NO_x
Emission Factor in lbs/kgal	2.00	1.00	0.25	7.1 *(142 S)*	24.0
Potential to Emit in tons/yr for	**3.92**	**1.96**	**0.49**	**13.9**	**47.1**

Emission factors are from AP-42, Tables 1.3-1, 1.3-2, 1.3-3, and 1.3-6 (AP-42, 05/10).
* Pursuant to 40 CFR 63.7555(d)(3) (NESHAP, Subpart DDDDD), limited use boilers means boilers that limit the annual capacity factor to less than or equal to

Methodology

PTE (tons/yr) = Max. Fuel Usage (kgal/hr) x Emission Factor (lbs/kgal) x Operation Hour Limit (hrs/yr) x 1 ton/2000 lbs x 2 units

Operation Hour Limit*
(hrs/yr)

876

VOC	CO
0.2	5.0
0.39	**9.81**

10 percent.

Appendix A: Emission Calculations
HAP Emissions
From Two (2) 308 MMBtu/hr Auxiliary Boilers

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Heat Input Capacity MMBtu/hr		Max. Fuel Usage (kgal/hr)		Operation Hour Limit* (hrs/yr)
308	(each)	2.24	(each)	876

	Pollutant					
	Chloride	Nickel	Fluoride	Vanadium	Formaldehyde	Total HAPs
Emission Factor in lbs/kgal	3.47E-01	8.45E-02	3.73E-02	3.18E-02	3.30E-02	6.05E-01
Potential to Emit in tons/yr for	**0.68**	**0.17**	**0.07**	**0.06**	**0.06**	**1.19**

Emission factors are from AP-42, Tables 1.3-9 and 1.3-11 (AP-42, 09/98).
The emission factor for total HAPs is the sum of the emission factors for organic HAP and metals.
* Pursuant to 40 CFR 63.7555(d)(3) (NESHAP, Subpart DDDDD), limited use boilers means boilers that limit the annual capacity factor to less than or equal to 10 percent.

Methodology

PTE (tons/yr) = Max. Fuel Usage (kgal/hr) x Emission Factor (lbs/kgal) x Operation Hour Limit (hrs/yr) x 1 ton/2000 lbs x 2 units

Appendix A: Emission Calculations
PM, PM10, and PM2.5 Emissions
From Coal Handling Operations

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Unit Description	Number of Units	Max. Capacity (tons/hr/unit)	PM Emission Factor* (lbs/ton)	PM10 Emission Factor* (lbs/ton)	PM2.5 Emission Factor* (lbs/ton)	Control Method	Control Efficiency (%)	PTE of PM after Control (tons/yr)	PTE of PM10 after Control (tons/yr)	PTE of PM2.5 after Control (tons/yr)
Railcar Unloading	1	10,000	0.00010	0.00010	0.00010	Wet Dust Suppression	50.0%	2.190	2.190	2.190
Feeders	12	200	0.00014	4.60E-05	1.30E-05	Wet Dust Suppression	50.0%	0.736	0.242	0.068
Conveyors BC-1 through BC-4	4	1,800	0.00014	4.60E-05	1.30E-05	Dust Collector DC-8	99.0%	0.044	0.015	0.004
Conveyor BC-4A	1	100	0.00014	4.60E-05	1.30E-05	Dust Collector DC-8	99.0%	0.001	0.000	0.000
Conveyors BFD-5A and BC-5	2	1,800	0.00014	4.60E-05	1.30E-05	Dust Collector DC-8	99.0%	0.022	0.007	0.002
Conveyor BC-6	1	1,500	0.00014	4.60E-05	1.30E-05	Dust Collector DC-8	99.0%	0.009	0.003	0.001
Conveyors BC-6A through BC-6C	3	1,800	0.00014	4.60E-05	1.30E-05	Wet Dust Suppression	50.0%	1.656	0.544	0.154
Conveyor BC-7	1	1,500	0.00014	4.60E-05	1.30E-05	Wet Dust Suppression	50.0%	0.460	0.151	0.043
Yard Surge Bin YSB-1	1	1,800	0.00014	4.60E-05	1.30E-05	Dust Collector DC-8	99.0%	0.011	0.004	0.001
Conveyors BC-8A and BC-8B	2	1,500	0.00014	4.60E-05	1.30E-05	Dust Collector DC-8	99.0%	0.018	0.006	0.002
Plant Surge Bin PSB-1	1	3,000	0.00014	4.60E-05	1.30E-05	Dust Collector DC-5	99.0%	0.018	0.006	0.002
Conveyors BC-9A and BC-9B	2	1,500	0.00014	4.60E-05	1.30E-05	Dust Collector DC-5	99.0%	0.018	0.006	0.002
Conveyors BC-10A and BC-10B	2	1,500	0.00014	4.60E-05	1.30E-05	Dust Collector DC-5	99.0%	0.018	0.006	0.002
Three (3) enclosed cascading conveying systems	3	1,500	0.00014	4.60E-05	1.30E-05	Dust Collectors DC-1 through DC-4, DC-6, and DC-7	99.0%	0.028	0.009	0.003
Silos 1A through 1G	7	3,000	0.00014	4.60E-05	1.30E-05	Dust Collector/Baghouse	99.0%	0.129	0.042	0.012
Silos 2A through 2G	7	3,000	0.00014	4.60E-05	1.30E-05	Dust Collector/Baghouse	99.0%	0.129	0.042	0.012
Silos 3A through 3G	7	3,000	0.00014	4.60E-05	1.30E-05	Dust Collector/Baghouse	99.0%	0.129	0.042	0.012
Total								**5.62**	**3.32**	**2.51**

* The emission factors are from AP-42, Table 11.19.2-2 (08/04).
Since the coal received at this facility has high moisture content (6.9%), the controlled emission factors in AP-42, Table 11.19.2-2 are used in the PTE calculations.

Methodology

PTE of PM/PM10/PM2.5 after Control (tons/yr) = Number of Units x Max. Capacity (tons/hr/unit) x Emission Factor (lbs/ton) x 8760 hrs/yr x 1 ton/2000 lbs x (1-Control Efficiency)

Appendix A: Emission Calculations
PM, PM10, and PM2.5 Emissions
From the Coal Storage Piles (Fugitive Emissions)

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

1. Emission Factors:

According to AP-42, Chapter 13.2.4 - Aggregate Handling and Storage Piles (11/06), the PM/PM10 emission factors for aggregate handling process can be estimated from the following equation:

$$Ef = \frac{k \times 0.0032 \times (U/5)^{1.3}}{(M/2)^{1.4}}$$

where:

Ef =	Emission Factor (lbs/ton)	
k =	Particle size multiplers =	0.74 for PM, 0.35 for PM10, and 0.053 for PM2.5
U =	Mean wind speed (mph) =	3.2 mph (provided by the source based on the data in 1999)
M =	Moisture content (%) =	3 % (provided by the source)

Therefore,

PM Emission Factor =	0.00075 lbs/ton
PM10 Emission Factor =	0.00036 lbs/ton
PM 2.5 Emission Factor =	0.00005 lbs/ton

2. Potential to Emit PM/PM10/PM2.5 after Control:

Max. Throughput Rate:	3,300 tons/hr
Control Efficiency:	50% for water suppression

PTE of PM after Control (tons/yr) = 3,300 tons/yr x 0.00075 lbs/ton x 8760 hr/yr x 1 ton/2000 lbs x (1-50%) = **### tons/yr**

PTE of PM10 after Control (tons/yr) = 3,300 tons/yr x 0.00036 lbs/ton x 8760 hr/yr x 1 ton/2000 lbs x (1-50%) = **### tons/yr**

PTE of PM2.5 after Control (tons/yr) = 3,300 tons/yr x 0.00005 lbs/ton x 8760 hr/yr x 1 ton/2000 lbs x (1-50%) = **### tons/yr**

Appendix A: Emission Calculations
PM, PM10, and PM2.5 Emissions
From Limestone Handling System

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Unit Description	Number of Unit	Max. Capacity (tons/hr)	PM Emission Factor* (lbs/ton)	PM10 Emission Factor* (lbs/ton)	PM2.5 Emission Factor* (lbs/ton)	Control Efficiency (%)	PTE of PM (tons/yr)	PTE of PM (tons/yr)	PTE of PM2.5 (tons/yr)
Truck Unloading	2	38.0	0.0001	0.0001	0.0001	0.00	0.03	0.03	0.03
Feeders	2	36.0	0.0030	0.0011	0.0011	0.00	0.95	0.35	0.35
Cleanout Conveyors	2	5.00	0.0030	0.0011	0.0011	0.00	0.13	0.05	0.05
Ball Mills	2	36.0	0.0054	0.0024	0.0024	0.00	1.70	0.76	0.76
Total							**2.81**	**1.19**	**1.19**

* The emission factora are from AP-42, Table 11.19.2-2 (08/04). Assume PM2.5 emission factors are equal to PM10 emission factors.

Methodology
PTE of PM/PM10/PM2.5 after control (tons/yr) = Num. of Units x Max. Capacity (tons/hr) x Emission Factor (lbs/ton) x 8760 hr/yr x 1 ton/2000 lbs x (1 - control efficiency)

Dust Collector ID	Grain Loading (gr/acfm)	Flow Rate (acfm)	Controlled PM/PM10/PM2.5 Emissions (lbs/hr)	Controlled PM/PM10/PM2.5 Emissions (tons/yr)	Control Efficiency (%)	Uncontrolled PM/PM10/PM2.5 Emissions (tons/yr)
DC-9	0.001	17,950	0.15	0.67	99%	67.4
DC-10	0.001	17,950	0.15	0.67	99%	67.4
DC-11	0.001	12,000	0.10	0.45	99%	45.1
Total				**1.80**		**180**

Methodology
Controlled Emissions (lbs/hr) = Grain Loading (gr/acfm) x Flow Rate (acfm) x 60 mins/hr x 1 lb/7000 gr
Controlled Emissions (tons/yr) = Controlled Emissions (lbs/hr) x 8760 hrs/yr x 1 ton/2000 lbs
Uncontrolled Emissions (tons/yr) = Controlled Emissions (tons/yr) / (1 - Control Efficiency)

PTE of PM after Control = 2.81 tons/yr + 1.80 tons/yr = 4.61 tons/yr
PTE of PM10 after Control = 1.19 tons/yr + 1.80 tons/yr = 2.98 tons/yr
PTE of PM2.5 after Control = 1.19 tons/yr + 1.80 tons/yr = 2.98 tons/yr

Appendix A: Emission Calculations
PM, PM10, and PM2.5 Emissions
From the Limestone Storage Piles (Fugitive Emissions)

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

1. Emission Factors:

According to AP-42, Chapter 13.2.4 - Aggregate Handling and Storage Piles (11/06), the PM/PM10 emission factors for aggregate handling process can be estimated from the following equation:

$$Ef = \frac{k \times 0.0032 \times (U/5)^{1.3}}{(M/2)^{1.4}}$$

where:

Ef =	Emission Factor (lbs/ton)	
k =	Particle size multipliers =	0.74 for PM, 0.35 for PM10, and 0.053 for PM2.5
U =	Mean wind speed (mph) =	3.2 mph (provided by the source based on the data in 1999)
M =	Moisture content (%) =	1 % (provided by the source)

Therefore,

PM Emission Factor =	0.0035 lbs/ton
PM10 Emission Factor =	0.0017 lbs/ton
PM2.5 Emission Factor =	0.0003 lbs/ton

2. Potential to Emit PM/PM10/PM2.5 after Control:

Max. Throughput Rate:	600 tons/yr
Control Efficiency :	50% for water suppression

PTE of PM after Control (tons/yr) = 600 tons/yr x 0.0035 x 8760 hr/yr x 1 ton/2000 lbs x (1-50%) = **### tons/yr**

PTE of PM10 after Control (tons/yr) = 600 tons/yr x 0.0035 x 8760 hr/yr x 1 ton/2000 lbs x (1-50%) = **### tons/yr**

PTE of PM2.5 after Control (tons/yr) = 600 tons/yr x 0.0003 x 8760 hr/yr x 1 ton/2000 lbs x (1-50%) = **### tons/yr**

Appendix A: Emission Calculations
PM, PM10, PM2.5, and HAP Emissions
From the Fly Ash Handling System

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Unit Description	Number of Units	Max. Capacity (tons/hr/unit)	PM Emission Factor* (lbs/ton)	PM10 Emission Factor* (lbs/ton)	PM2.5 Emission Factor* (lbs/ton)	Control Method	Control Efficiency (%)	PTE of PM after Control (tons/yr)	PTE of PM10 after Control (tons/yr)	PTE of PM2.5 after Control (tons/yr)
Fly Ash Silos	2	46	2.20	2.20	2.20	Dust Collectors	99.0%	8.87	8.87	8.87
Truck Loading for Fly Ash	2	38	0.61	0.61	0.61	Dust Collectors	90.0%	20.3	20.3	20.3
Total								**29.2**	**29.2**	**29.2**

* The emission factors are from AP-42, Table 11.17-4 for Lime Manufacturing Process (02/98).
Assume the PM10 and PM2.5 emissions are equal to PM emissions.

Methodology

PTE of PM/PM10/PM2.5 after Control (tons/yr) = Num of Units x Max. Capacity (tons/hr/unit) x Emission Factor (lbs/ton) x 8760 hr/yr x 1 ton/2000 lbs x (1-Control Efficiency)

Potential to Emit HAPs

HAP	HAP Concentration* (ton per ton ash)	PTE of HAP (tons/yr)
Beryllium	6.097E-06	1.78E-04
Chromium	2.485E-05	7.25E-04
Lead	2.650E-05	7.73E-04
Manganese	1.372E-04	4.00E-03
Nickel	2.893E-05	8.44E-04
Total HAPs		**6.52E-03**

*HAP concentration values are based on the 4/26/99 NGS coal analysis data.

Methodology

PTE of HAP after Control (tons/yr) = PTE of PM after Control (tons/yr) x HAP Concentration (ton/ton of ash)

Appendix A: Emission Calculations
PM, PM10, and PM2.5 Emissions
From the Soda Ash/Lime Handling Systems

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Unit Description	Number of Units	Max. Capacity (tons/hr/unit)	PM/PM10/PM2.5 Emission Factor* (lbs/ton)	PTE of PM/PM10/PM2.5 before Control (tons/yr)	Control Method	Control Efficiency (%)	PTE of PM/PM10/PM2.5 after Control (tons/yr)
Soda Ash Silos	4	0.40	2.20	15.4	Dust Collector	99.0%	0.15
Lime Silos	2	0.57	2.20	11.0	Baghouse	99.0%	0.11
Total				**26.4**			**0.26**

* The emission factors are from AP-42, Table 11.17-4 for Lime Manufacturing Process (02/98).
Assume the PM10 and PM2.5 emissions are equal to PM emissions.

Methodology

PTE of PM/PM10/PM2.5 before Control (tons/yr) = Number of Units x Max. Capacity (tons/hr/unit) x Uncontrolled Emission Factor (lbs/ton) x 8760 hrs/yr x 1 ton/2000 lbs
PTE of PM/PM10/PM2.5 after Control (tons/yr) = PTE of PM/PM10 before Control (tons/yr) x (1-Control Efficiency)

Appendix A: Emission Calculations
PM, PM10, and PM2.5 Emissions
From the Cooling Towers

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

1. Process Description:

Circulation Flow Rate:	813,000	gal/min (6 cooling towers total)
Total Drift:	0.0009%	of the circulating flow (provided by the source)
Total Dissolved Solids:	12,000	ppm
Density:	8.328	lbs/gal
% Not Deposited on Site:	10%	(provided by the source)

2. Potential to Emit PM/PM10/PM2.5:

Assume PM emissions are equal to PM10 emissions.

PTE of PM/PM10/PM2.5 (lbs/hr) = 813,000 gal/min x 60 min/hr x 0.0009% x 8.328 lbs/gal x 12,000 ppm x 1/1,000,000 ppm x 10% = **4.39 lbs/hr**

PTE of PM/PM10/PM2.5 (tons/yr) = 4.40 lbs/hr x 8760 hrs/yr x 1 ton/2000 lbs = **19.2 tons/yr**

Appendix A: Emission Calculations
Fugitive Emissions
From Unpaved Roads

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

1. Emission Factors:

According to AP42, Chapter 13.2.2 - Unpaved Roads (11/06), the PM/PM10/PM2.5 emission factors for unpaved roads can be estimated from the following equation:

$$E = k \times (s/12)^a \times (w/3)^b \times (365-p)/365$$

where:

E =	emission factor (lb/vehicle mile traveled)		
s =	surface material silt content (%) =	5.1	% (AP-42, Table 13.2.2-1)
w =	mean vehicle weight (tons) =	78.1	tons (see the calculations below)
k =	empirical constant =	4.9 for PM, 1.5 for PM10, and 0.15 for PM2.5	
a =	empirical constant =	0.7 for PM, 0.9 for PM10, and 0.9 for PM2.5	
b =	empirical constant =	0.45	
p =	number of days per year with 0.01 inches precipitation	60	(see Fig 13.2.2-1 in AP42)

PM Emission Factor =	$4.9 \times (5.1/12)^{0.7} \times (78.1/3)^{0.45} \times (365-60)/365$	=	**9.8 lbs/mile**
PM10 Emission Factor =	$1.5 \times (5.1/12)^{0.9} \times (78.1/3)^{0.45} \times (365-60)/365$	=	**2.52 lbs/mile**
PM2.5 Emission Factor =	$0.15 \times (5.1/12)^{0.9} \times (78.1/3)^{0.45} \times (365-60)/365$	=	**0.25 lbs/mile**

2. Potential to Emit (PTE) of PM/PM10/PM2.5 Before Control from Unpaved Roads:

Vehicle Type	Number of Units	Ave. Vehicle Weight* (tons)	Vehicle Miles Traveled* (VMT) (miles/day/unit)	Total Vehicle Miles Traveled (VMT) (miles/yr)	Traffic Component (%)	Component Vehicle Weight (tons)	PTE of PM (tons/yr)	PTE of PM10 (tons/yr	PTE of PM2.5 (tons/yr)
Service/Fuel Truck	1	16.5	15.0	5,475	2.44%	0.40	26.7	6.89	0.69
Service/Fuel Truck	1	13.2	18.0	6,570	2.93%	0.39	32.0	8.3	0.83
Ash Trucks	3	102	90.0	98,550	44.0%	44.8	480	124	12.4
Ash Truck	1	102	12.0	4,380	1.95%	1.99	21.4	5.51	0.55
D65 Dozer	1	22.0	5.00	1,825	0.81%	0.18	8.9	2.30	0.23
D31 Dozer	1	8.00	2.00	730	0.33%	0.03	3.56	0.92	0.09
Rubber Tire Dozer	1	33.5	1.00	365	0.16%	0.05	1.78	0.46	0.05
13 -Yard Loader	1	72.0	7.00	2,555	1.14%	0.82	12.5	3.21	0.32
6-Yard Loader	1	24.0	2.00	730	0.33%	0.08	3.56	0.92	0.09
2.5-Yard Loaders	2	12.5	2.00	1,460	0.65%	0.08	7.12	1.84	0.18
7-Yard Loader	1	54.5	3.00	1,095	0.49%	0.27	5.34	1.38	0.14
8,000-Gallon Waterpulls	1	36.5	30.0	10,950	4.88%	1.78	53.4	13.8	1.38
12,000-Gallon Waterpulls	1	115	127	46,355	20.7%	23.8	226	58.3	5.83
12-Yard Crystallizer Trucks	3	13.0	2.00	2,190	0.98%	0.13	10.7	2.75	0.28
12-Yard Dump Trucks	4	11.6	1.00	1,460	0.65%	0.08	7.12	1.84	0.18
14G Grader	1	28.0	10.0	3,650	1.63%	0.46	17.8	4.59	0.46
El 300 Excavator	1	34.0	0.14	51	0.02%	0.01	0.25	0.06	0.01
140H Grader	1	19.8	1.00	365	0.16%	0.03	1.78	0.46	0.05
Road Trucks	2	11.0	1.00	730	0.33%	0.04	3.56	0.92	0.09
724 Vac Truck	1	19.8	3.00	1,095	0.49%	0.10	5.34	1.38	0.14
2.5 Yar Loader (928)	3	12.5	2.00	2,190	0.98%	0.12	10.7	2.75	0.28
NPG-797 Bucket Truck	1	20.6	40.0	14,600	6.51%	1.34	71.2	18.36	1.84
NPG-733 Bucket Truck	1	14.6	46.0	16,790	7.49%	1.09	81.9	21.12	2.11
Total				**224,161**	**100%**	**78.1**	**1,093**	**282**	**28.2**

* This information is provided by the source.

Methodology
Component Vehicle Weight = Ave. Vehicle Weight (tons) x Traffic Component (%)
(Note that the summation of the component vehicle weight equals the Mean Vehicle Weight.)
VMT(miles/yr) = VMT (miles/day/unit) x 365 days/yr x Number of Units
PTE of PM/PM10/PM2.5 (tons/yr) = VMT (miles/yr) x Emission Factor (lbs/mile) x 1 ton/ 2000 lbs

3. Potential to Emit (PTE) of PM/PM10/PM2.5 after Control from Unpaved Roads:

Control Efficiency : 50% for continuous water suppression

PTE of PM after Control =	1,093 tons/yr x (1-50%) =		**546 tons/yr**
PTE of PM10 after Control =	282 tons/yr x (1-50%) =		**141 tons/yr**
PTE of PM2.5 after Control =	28.2 tons/yr x (1-50%) =		**14.1 tons/yr**

Power Output
Horse Power (HP)

2,861	(9 units total)

	Pollutant
Emission Factor in lb/HP-hr	
Potential to Emit (PTE) in tons/yr	

Emission factors are from AP-42, Table 3.3-1 (10/96).
Assume PM10/PM2.5 emissions equal PM emissions. TOC (total organic compounds) emissions equal VOC emissions.

Note: As defined in the September 6, 1995 memorandum from John S. Seitz of US EPA on the subject of "Calculating Potential to Emit for Emergency Generators", an emergency generator's sole function is to provide back-up power when power from the local utility is interrupted. The only circumstances under which an emergency generator would operate when utility power is available are during operator training or brief maintenance checks. The generator's potential to emit is based on an operating time of 500 hours per year as set forth in the EPA memo.

Methodology

PTE (tons/yr) = Power Output (HP) x Emission Factor (lb/HP-hr) x Operation Limit (hr/yr) x 1 ton/2000 lbs

Appendix A: Emission Calculations

Internal Combustion Engines

From the Diesel Emergency Generators

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

Operation Limit*
(hrs/yr)

500

PM	PM10/PM2.5	SO_2	NO_x	VOC	CO
2.20E-03	2.20E-03	2.05E-03	3.10E-02	2.47E-03	6.68E-03
1.57	**1.57**	**1.47**	**22.2**	**1.77**	**4.78**

Appendix A: Emission Calculations

PTE Summary

Company Name: Navajo Generating Station
Address: 5 miles east of Page, off U.S. Highway 98, Page, AZ 86040
Permit No.: NN-ROP-13-06
Reviewer: ERG/YC
Date: July 21, 2014

PM	PM10	PM2.5	SO_2	NO_x	VOC	CO	Total HAPs
1,947	1,097	488	3,246	7,789	75.3	4,868	22.7
1,947	1,097	488	3,246	7,789	75.3	4,868	22.7
1,947	1,097	488	3,246	7,789	75.3	4,868	22.7
3.92	1.96	0.49	13.9	47.1	0.39	9.81	1.19
5.62	3.32	2.51	-	-	-	-	-
5.43	2.57	0.39	-	-	-	-	-
4.61	2.98	2.98	-	-	-	-	-
4.60	2.17	0.33	-	-	-	-	-
29.2	29.2	29.2	-	-	-	-	0.01
0.26	0.26	0.26	-	-	-	-	-
19.2	19.2	19.2	-	-	-	-	-
546	141	14.1	-	-	-	-	-
1.57	1.57	1.57	1.47	22.2	1.77	4.78	Negligible
15.3	15.3	15.3	-	-	5.00	-	Negligible
6,478	**3,511**	**1,549**	**9,752**	**23,437**	**233**	**14,620**	**69.3**

Limited Potential To Emit after Control

Emission Units
Boiler U1
Boiler U2
Boiler U3
Auxiliary Boilers
Coal Handling Operations
Coal Piles (Fugitive)
Limestone Handling Operations
Limestone Piles (Fugitive)
Fly Ash Handling Operations
Soda Ash/Lime Handling Operations
Cooling Towers
Unpaved Roads (Fugitive)
Emergency Generators (Insignificant)
Other Insignificant Activities*
Total PTE (tons/yr)

*Note: PM10 emissions are from the welding and the abrasive blasting operations and are based on the information provided in the permit application received on 01/04/13. Assume PM10 emissions are equal to PM/PM2.5 emissions. VOC/HAP emissions are the estimated emissions from the parts cleaning, surface coating operations, and the storage tanks.